REMARKS

By the present amendment claims 1 to 3 and 5 are under consideration in the application. Claim 6 has been withdrawn due to the restriction requirement.

Amendments To The Claims

Support for the amendment to claims 1 and 2 setting the lower limit of Si as --1.2%-- may be found in Table 1 of the specification at page 13 wherein Steels N, O, X, Y and Z have an Si content of 1.2%.

Support for amending claims 1 and 2 to recite --wherein Mg content of the steel of said steel is limited to less than 0.0005%-- may be found in the specification as follows. The specification at page 7, lines 20 to 21 clearly discloses that Mg is an optional chemical component. The specification at page 7, line 31 to 32 discloses that Mg has no effect when the Mg content is less than 0.0005%. Therefore, less than 0.0005% Mg means that the optional Mg, as a practical matter, is not present in the steel.

§103

Claims 1 to 3 and 5 were rejected under 35 U.S.C. §103(a) as being unpatentable over Japan No. 2001-342543 or U.S. Patent No. 6,364,968 to Yasuhara et al. alone or in view of U.S. Patent No. 5,470,529 to Nomura et al.

These rejections, as applied to the amended claims, are respectfully traversed.

The Present Invention

The present invention provides as claimed in the amended claim 1, a high-strength hot-rolled steel sheet excellent in hole expandability and ductility, consisting essentially of, in terms of mass %.

C: 0.01 to 0.09%, Si: 1.2 to 1.5%, Mn: 0.5 to 3.2%, Al: 0.003 to 1.5% P: 0.03% or below, S: 0.005% or below, Ti: 0.10 to 0.25%, Nb: 0.01 to 0.05%, and the balance being iron and unavoidable impurities, wherein Mg content of the steel of said steel sheet is limited to less than 0.0005% and satisfying all of the following formulas <1> to <3>:

$$0.9 \leq 48/12 \times C/Ti < 1.7 \quad \ldots \quad <1>$$

$$50,227 \times C - 4479 \times Mn > -9860 \quad \ldots \quad <2>$$

$$811 \times C + 135 \times Mn + 602 \times Ti + 794 \times Nb > 465 \quad \ldots \quad <3>$$, and

having strength of at least 980 N/mm^2, and as claimed in the amended claim 2, a high-strength hot-rolled steel sheet excellent in hole expandability and ductility, consisting essentially of, in terms of mass %:

C: 0.01 to 0.09%, Si: 1.2 to 1.5%, Mn: 0.5 to 3.2%, Al: 0.003 to 1.5%, P: 0.03% or below, S: 0.005% or below, Ti: 0.10 to 0.25%, Nb: 0.01 to 0.05%, and at least one of Mo: 0.05 to 0.40% and V: 0.001 to 0.10%, and the balance being iron and unavoidable impurities, wherein Mg content of the steel of said steel sheet is limited to less than 0.0005% and satisfying all of the following formulas <1>' to <3>':

$$0.9 \leq 48/12 \times C/Ti < 1.7 \quad \ldots \quad <1>'$$

$$50,227 \times C - 4479 \times (Mn + 0.57 \times Mo + 1.08 \times V) > -9860 \quad \ldots \quad <2>'$$

$$811 \times C + 135 \times (Mn + 0.57 \times Mo + 1.08 \times V) + 602 \times Ti + 794 \times Nb > 465 \quad \ldots \quad <3>'$$,

and having strength of at least 980 N/mm^2.

In order to obtain an high-strength hot-rolled steel sheet having strength of at least 980 N/mm^2, one rank higher than that of the steel sheet disclosed in the cited references (discussed later), and also having excellent hole expandability and ductility, the present

invention utilizes strengthening due to TiC precipitation and the influence of structure strengthening due to C and Mn on the properties of steel material, and defines the range of the components C, Mn, and Ti by formulas <1> (<1>') and <2> (<2>'), and further defines the range of components Mn, Ti, Nb and/or Mo and V by the formula <3> (<3>').

As described in the specification, e.g., at page 9, lines 19 to 31, although in the steel sheet having a strength level of 780N/mm^2, it is sufficient and easy to satisfy formulas <1> and <2> to obtain formability while securing the strength, it is essential that the components further satisfy formula <3> to, in accordance with the present invention, obtain the strength of at least 980 N/mm^2 of the present invention.

According to the present invention, the high-strength hot-rolled steel sheet excellent in hole expandability and ductility and having strength of at least 980 N/mm^2 can be obtained by defining the composition and controlling the content of components so as to satisfy the three formulas of <1> to <3> (<1>' to <3>').

Patentability

Japan No. 2001-342543 ("JP '543")

The steel sheet disclosed in JP '543 secures a strength of the 590 to 780 N/mm^2 class, hole expandability and ductility (See Problem To Be Solved in Abstract of JP '543) by essentially adding Mg to the steel and finely dispersing a specified number of pieces of MgO or composite oxides composed of MgO and one or more of Al_2O_3, SiO_2, MnO and Ti_2O_3.

On the other hand, as explained above, in the steel sheet of the present invention, it is essential to satisfy the formula <1> to <3> (<1>' to <3>') in order to secure a strength of at least 980 N/mm^2, hole expandability and ductility without the steel substantially containing Mg, i.e., Mg limited to less than 0.0005%.

JP '543 requires 0.0005% to 0.01% of Mg to improve hole expandability, and as described in paragraph [0023] of this document, this effect is not sufficient if the Mg content is less than 0.0005%.

Further, steels of Comparative Examples A4 to A6, B7 to B9 in Table 1 of JP '543 have Mg content of less than 0.0005% (0.000 to 0.0004%) and show a tensile strength of 694 to 649 MPa, i.e., they are all lower than 980MPa.

To the contrary, steels of the present invention which do not substantially contain Mg, i.e., Mg content is less than 0.0005%, are Example steels of A to S in Table 1 at page 13 of the specification and have tensile strength of 986 to 1106 MPa as shown in Examples Al to S3 except comparative examples C3, J2, P2 and S3 in Tables 3 and 4, i.e., they are all higher than 980MPa.

Therefore, JP '593 does not suggest limiting Mg content to less than 0.0005% to improve hole expandability as well as ductility and high strength.

As explained above, in order to secure excellent hole expandability as well as excellent ductility and high strength, the present invention requires satisfying the equations <1> to <3> (<1>' to <3>') instead of requiring addition of Mg to the steel.

As explained above, the present invention enables a high strength hot-rolled steel sheet having strength of at least 980N/mm^2, excellent hole expandability and ductility wherein <u>Mg content of said steel is limited to less than 0.0005%</u>, i.e., Mg is not substantially contained. Therefore the present invention is not disclosed or suggested by JP '593.

<u>U.S. Patent No. 6,364,968 ("US '968")</u>

The steel sheet disclosed in US '968 contains 1.0% or less of Si (about 0.03 to 1.0%), while, as amended, the steel sheet of the present invention contains 1.2% to 1.5% of Si.

As described in US '968 (column 6, lines 12 to 17) "Si exhibits an action to increase the hot deformation resistance. If Si is added in excess of about 1.0 wt%, such an action will be especially notable and hot rolling into thin sheet intended by the invention becomes difficult. Therefore the Si content should be not more than about 1.0 wt%." US '968 defines the Si content as 1.0 wt% or less.

The Examples of US '968 all shows the Si content of less than 1.0 wt%.

<u>US '968 clearly teaches away from an Si addition of more than 1.0%</u>.

US '968 does not disclose or suggest the present invention.

<u>U.S. Patent No. 5,470,529 ("US '529")</u>

The steel sheets disclosed in US '529 all have low strength, 601 to 902 MPa shown in Tables 3-1, 3-2, 4-1 and 4-2, and do not satisfy the requirement of 980 N/mm^2 or higher of the present invention.

Note that although the Examples of Run No. 15, 18 and 19 in Table 6 of US '529 show a tensile strength of 1224Mpa, 986MPa and 1408MPa, respectively, and satisfy the requirement of 980 N/mm^2 or higher of the present invention, C content of the steel composition (I, L, M) of these steel sheets is 0.15, 0.27% and 0.47%, respectively, and is <u>far outside the range of the present invention.</u>

Further, note that although the Examples of Run No. 34, 41 and 45 in Table 7 show tensile strength of 1702Mpa, 1311 MPa and 1311 MPa, respectively and satisfy the requirement of 980 N/mm^2 or higher of the present invention, C content of the steel composition (D, I, M) of these steel sheets is 0.24%, 0.15% and 0.47%, respectively and is <u>far outside the range of the present invention</u>.

Likewise, note that although the Examples of Run No. 19 and 20 in Table 9 show tensile strength of 1052 Mpa and 1086 MPa, respectively, and satisfy the requirement of 980 N/mm^2 or higher of the present invention, C content of the steel composition (19, 20)

of these steel sheets is 0.28% and 0.48%, respectively, and is <u>far outside the range of the present invention</u>.

Although C is also added to secure strength in the present invention, the range of C content is limited to 0.01 to 0.09% in order to obtain excellent hole expandability and ductility.

In the present invention, in order to secure strength of 980 N/mm^2 or higher while limiting the C range to a low content, the present invention defines the formula <3> and controls the composition so as to satisfy this formula.

It is therefore submitted that independent claims 1 and 2, and all claims dependent thereon, are patentable over JP '543 and/or US '968 in view of US '529.

CONCLUSION

It is submitted that in view of the present amendment and foregoing remarks, the application is now in condition for allowance. It is therefore respectfully requested that the application, as amended, be allowed and passed for issue.

Respectfully submitted,

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